A NOVEL DEVICE FOR 3D ANATOMICAL LANDMARKS LOCALISATION

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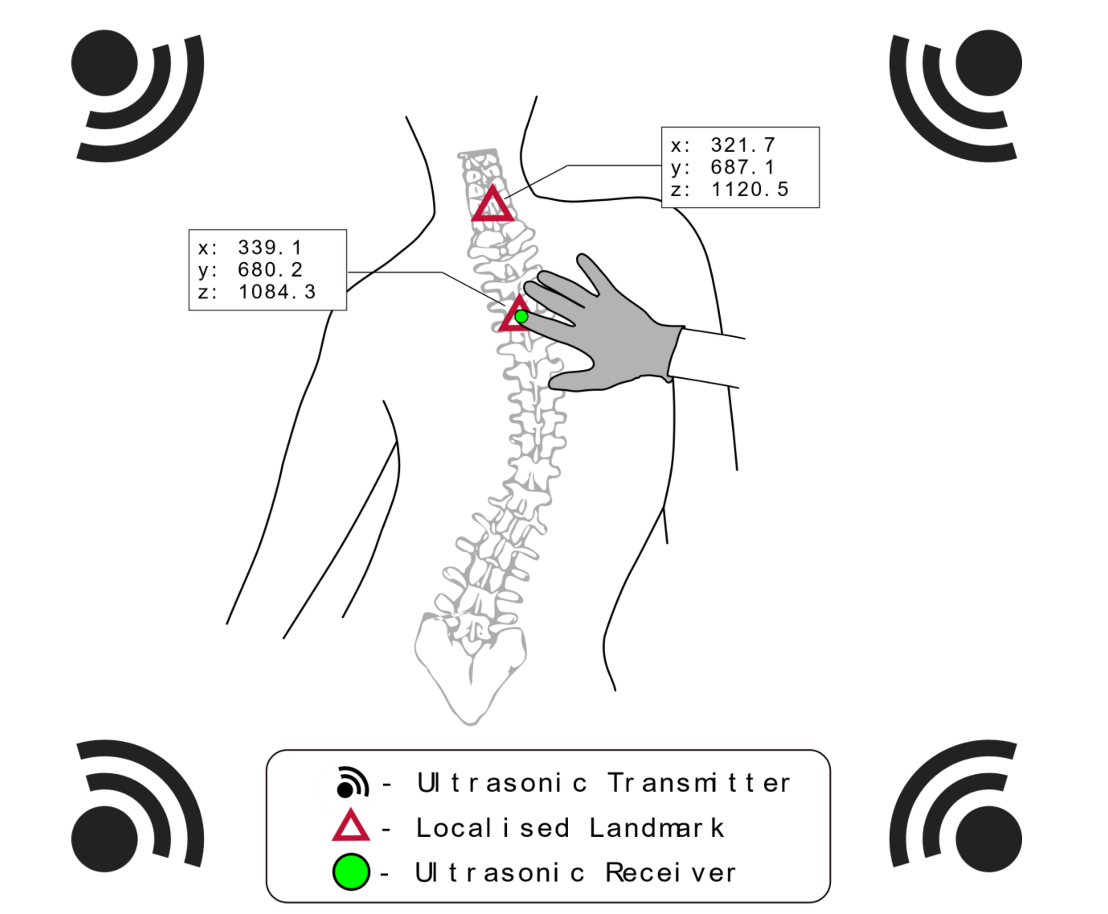
ABSTRACT

A device for anatomical landmarks localisation is being developed which uses ultrasonic signals to measure the position of the landmarks in three dimensions with a miniature receiver embedded in a glove. This tool will aid in postural assessment of individuals with severe musculoskeletal problems.

Research to date has been focused on the development of signal processing algorithms that will allow for the device to be used in environments with noise and interference sources.

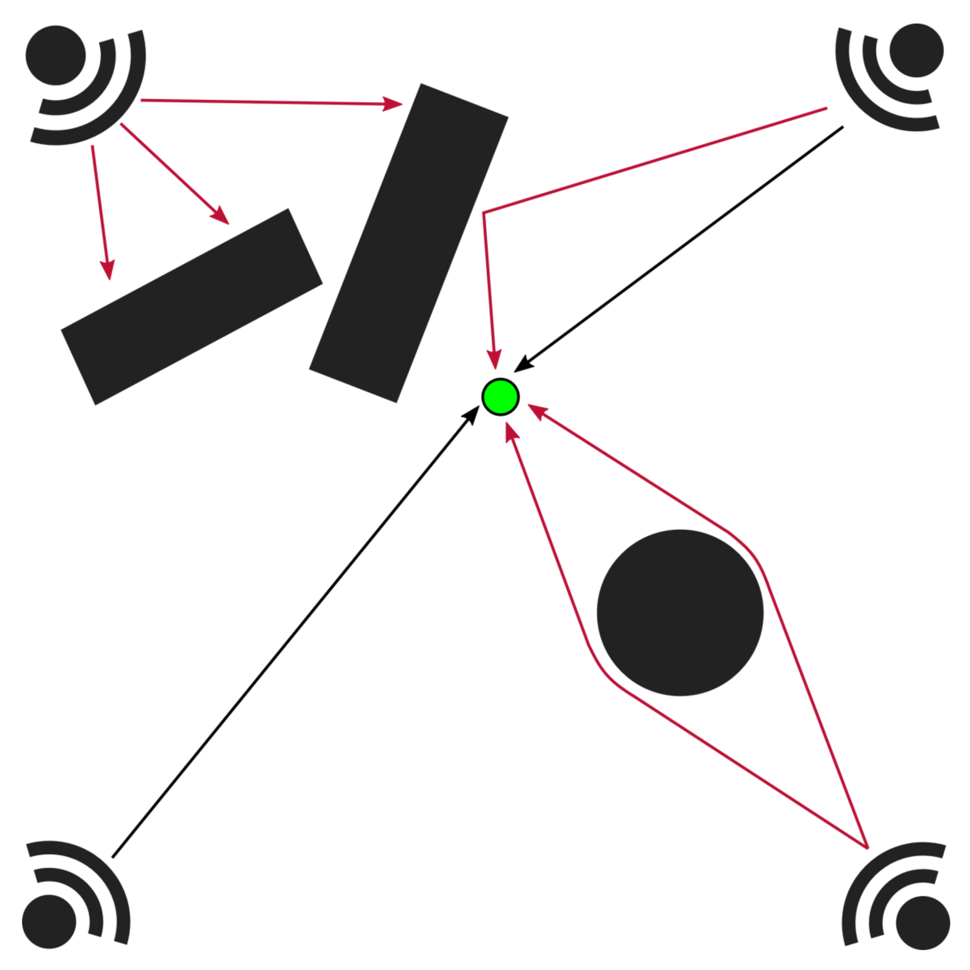
Experiments have been performed to test the developed algorithms, and the results showed that the device could be used for accurately capturing the position of anatomical landmarks.

PROTOTYPE CONCEPT



Ultrasonic localisation has many advantages that makes it very suitable for this purpose. The signals are non invasive, causes no discomfort to humans and the low speed of sound allows for localisation to be performed with high accuracy.

CHALLENGES



Despite the advantages, there are major challenges which must be addressed. This diagram shows the common problems associated with ultrasonic localisation.

1) Diffraction (lower right)
2) Reflection (upper right)
3) Complete blockage (upper left)

ROBUST LOCALISATION

The novel algorithm has been developed to counteract the effect of unwanted reflections and signal blockage and provide robust localisation.

After receiving signals from the transmitters a probability is assigned to each one based upon its amplitude.

Signals are sent to an iteratively reweighted regression, the probabilities are used as initial weights. At each iteration a reweighting rule is used to recalculate each signals weight, depending on its residual and probability.

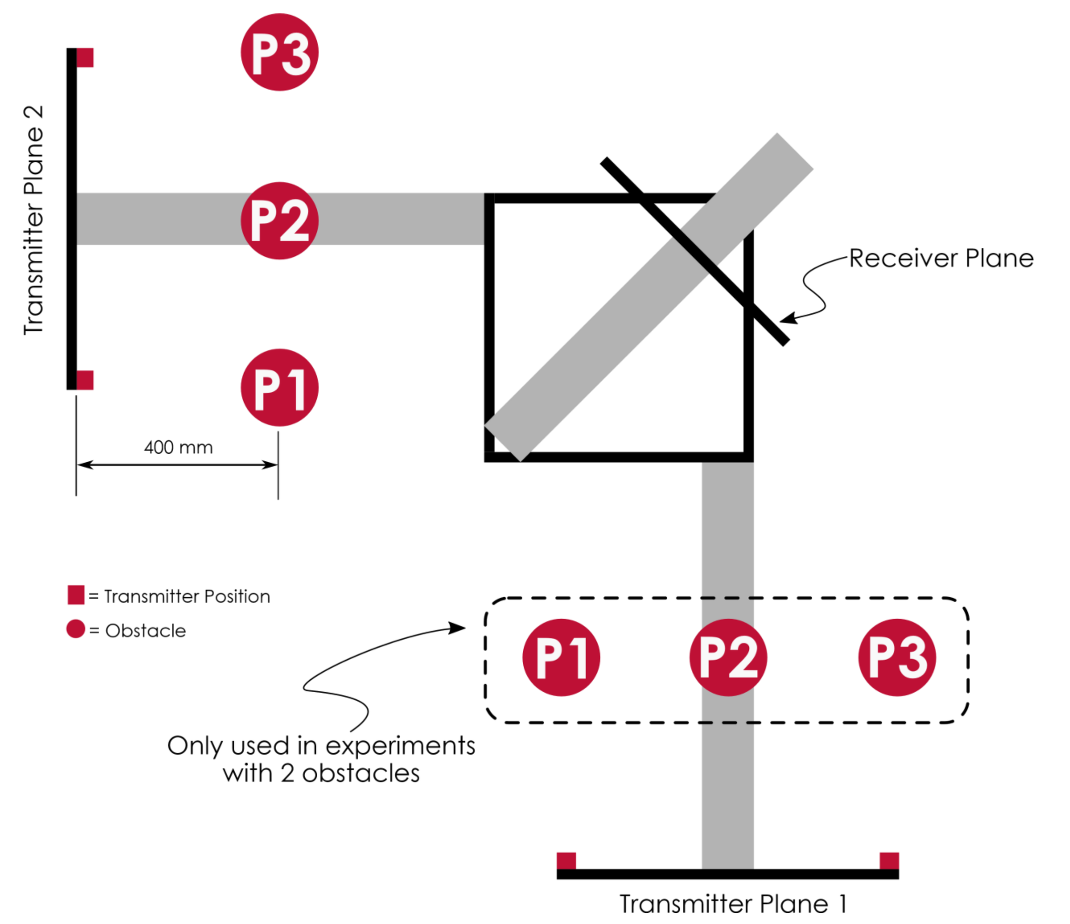
A fault detection and exclusion method has also been developed to double check the results of the previous step, increasing the robustness. This step is essential when there is the possibility of blocked signals, since the combination of a blocked line of sight signal and the multipath reflections increases the chances of incorrect classification.

Using this method the weights of each reflected or diffracted signal will go to zero, allowing them to be eliminated from the position calculation.

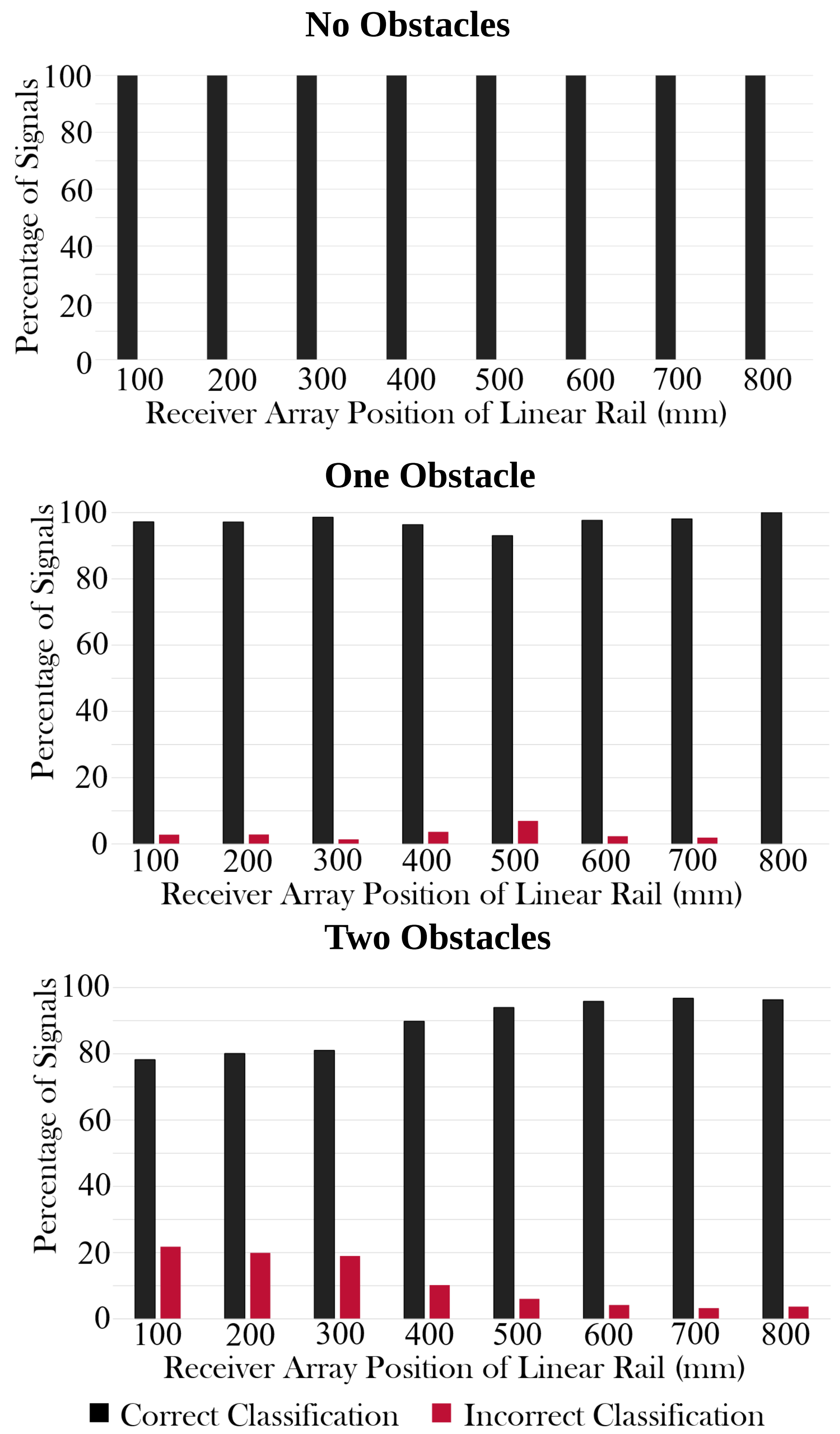
TESTING

Experiments were conducted to test the effectiveness of the developed algorithms

Cylindrical obstacles were placed in the space between the transmitters and receivers. The blockages ensured that data was collected with a wide variety of reflected, diffracted and completely block signals.



RESULTS



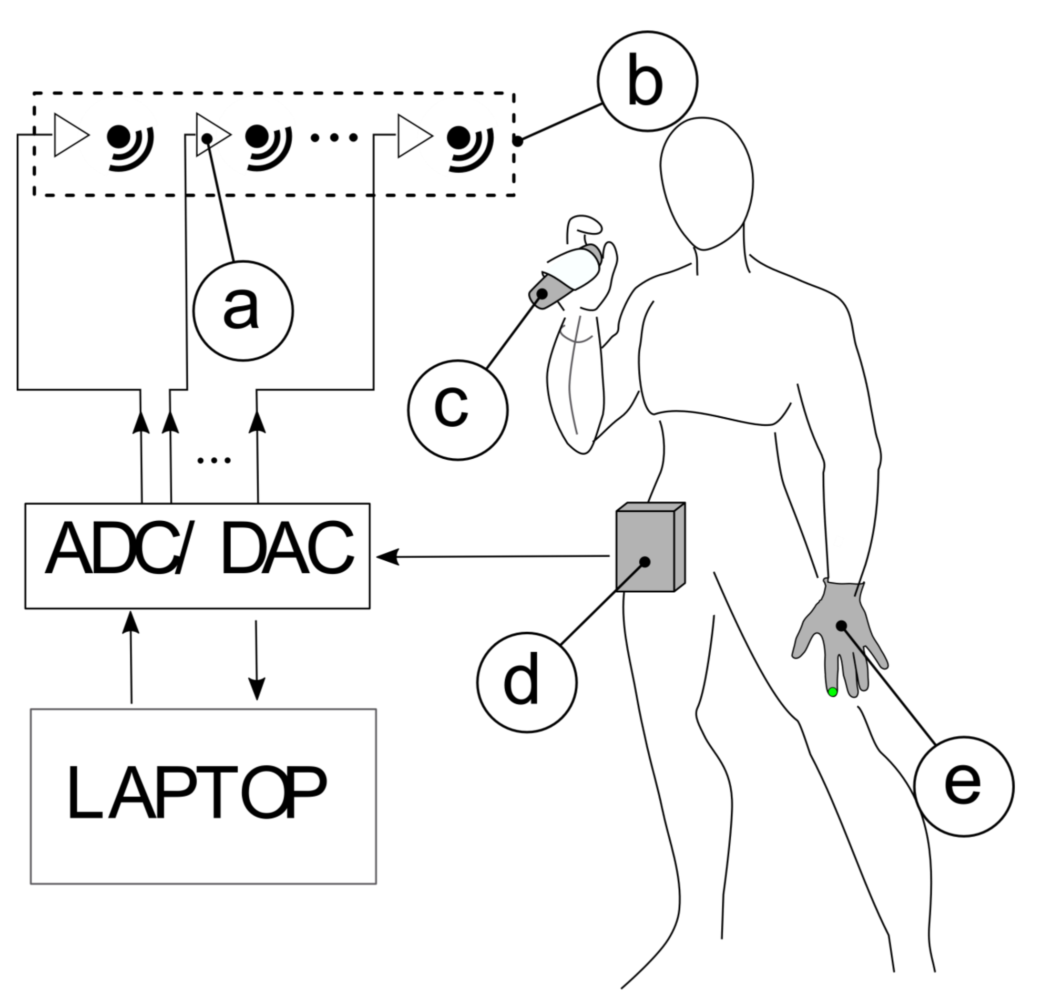
These plots show the percentage of signals that were correctly and incorrectly classified for all experiments conducted with zero, one or two obstacles present.

These results show that in all but the most extreme cases the algorithm can classify over 90% of signals correctly. These results are very encouraging and represent a significant milestone for the project.

FUTURE WORK

Further work is now required to develop a working prototype of the measurement tool.

a) Output amplifier
b) Transmitter array
c) Trigger device
d) Wearable signal conditioner and amplifier



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